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[54] **SYSTEM METHOD AND APPARATUS USING MULTIPLE RESOLUTION MACHINE READABLE SYMBOLS**

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[51] **Int. Cl.**[5] **G06K 7/10**; G06K 9/36; G06K 19/00; G06K 19/06

[52] **U.S. Cl.** **235/494**; 235/456; 380/51; 382/56

[58] **Field of Search** 235/494, 456, 454; 380/51; 382/56

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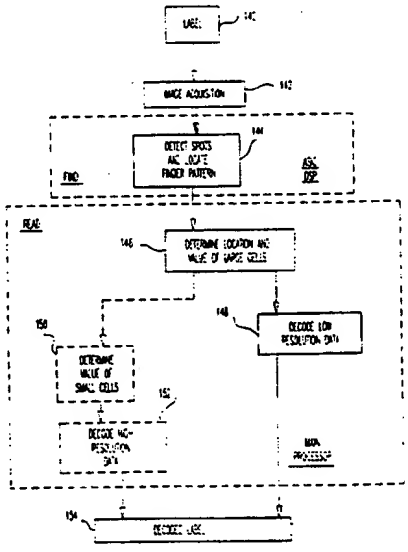
[57] **ABSTRACT**

A multiple resolution optically encoded label is readable at two or more optical resolutions, and is able to store two or more respective channels of optically encode information. Low resolution information is encoded in a plurality of large cells arranged in a predetermined geometric pattern. Each of the large cells includes a plurality of smaller cells for storing high resolution information. Method and apparatus are disclosed for encoding both high resolution data, and low resolution data, as well as for finding and reading both high resolution and low resolution data.

38 Claims, 15 Drawing Sheets



Most of the advantages of low resolution encoding and decoding are realized in the image acquisition system. The depth of field increases, permitting the use of fixed focus optics having reduced tolerances, and the required illumination power is reduced. The required size of the image buffer memory is reduced, and the data processing requirements are reduced as a result of having less data at a slower rate to process. For example, low resolution information may be sampled at 32 pixels per inch at 4 bits per pixel. A large cell which has a diameter of 3 pixels results in 2 to 3 samples per cell. The diameter of the high resolution cells is approximately ⅓ the diameter of the low resolution cells. Therefore the optics and imager in a high resolution system must resolve features 3 times smaller than a low resolution system. Therefore it may be necessary to use a lens with variable focus and/or zoom, a distance measuring device to measure the label distance in order to set the focus and/or zoom prior to capturing the image. The image must be of higher resolution. Finally, the high resolution image buffer must be at least 9 times the size of the low resolution image buffer since the sampling factor is increased by a factor of 3 in both directions.

The label, process and system of the present invention takes advantage of the low resolution large cell features, while encoding high resolution data at a very high density. If only low resolution data is necessary, the overall optical reader system is much less complex than a high and low resolution system. Only when high resolution data is necessary, will the additional complexity of a high resolution optical reader system be required.

What is claimed is:

1. A system arrangement using a multiple resolution optically encoded label having a first plurality of low resolution information encoded data cells, and a second plurality of high resolution information encoded data cells at least partially superimposed with said first plurality of low resolution information encoded data cells and encoding information independent of said first plurality of low resolution information encoded data cells, wherein each of said second plurality of high resolution information encoded data cells is smaller than each of said first plurality of low resolution information encoded data cells, said system comprising:

a first plurality low resolution readers for decoding said optically encoded multiple resolution label to read said low resolution first information encoded data cells; and

a second plurality of high resolution readers for decoding said optically encoded multiple resolution label to read said low resolution first information encoded data cells and said high resolution second information encoded data cells.

2. In a system arrangement using a multiple resolution optically encoded label having a first plurality of low resolution information encoded data cells, and a second plurality of high resolution information encoded data cells at least partially superimposed with said first plurality of low resolution information encoded data cells and encoding information independent of said first plurality of low resolution information encoded data cells, wherein each of said second plurality of high resolution information encoded data cells is smaller than each of said first plurality of low resolution information encoded data cells, a method comprising:

decoding said optically encoded multiple resolution label to read said low resolution first information encoded data cells at a first location in said system; and

decoding said optically encoded multiple resolution label to read said high resolution second information encoded data cells at a second location in said system.

3. An item sorting system comprising:

a multiple resolution optically encoded label on said item, said multiple resolution optically encoded label having a first plurality of low resolution information encoded data cells, and a second plurality of high resolution information encoded data cells at least partially superimposed with said first plurality of low resolution information encoded data cells and encoding information independent of said first plurality of low resolution information encoded data cells, wherein each of said second plurality of high resolution information encoded data cells is smaller than each of said first plurality of low resolution information encoded data cells, said low resolution first information encoded data cells encoding sorting information for said item, and said high resolution second information encoded data cells encoding other identifying information for said item; means for decoding said multiple resolution optically encoded label to read said low resolution sorting information from said first information encoded data cells at a first location in said item sorting system; and

means for sorting said item responsive to said decoded sorting information.

4. An item sorting system in accordance with claim 3, wherein said low resolution first information encoded data cells encoding sorting information for said item encode zip code information representing the destination for said item.

5. A method for use in an item sorting system, said method comprising:

optically encoding a label having a first plurality of low resolution information encoded data cells, and a second plurality of high resolution information encoded data cells at least partially superimposed with said first plurality of low resolution information encoded data cells and encoding information independent of said first plurality of low resolution information encoded data cells, wherein each of said second plurality of high resolution information encoded data cells is smaller than each of said first plurality of low resolution information encoded data cells, said low resolution first information encoded data cells encoding sorting information for said item, and high resolution second information encoded data cells encoding other identifying information for said item;

decoding said multiple resolution optically encoded label to read said low resolution sorting information from said first information encoded data cells at a first location in said item sorting system; and

sorting said item responsive to said decoded sorting information.

6. A method for use in an item sorting system in accordance with claim 5, wherein said low resolution first information encoded data cells encoding sorting information for said item encode zip code information representing the destination for said item.

7. In a reader for reading an optically encoded multiple resolution label having a first plurality of low resolution information encoded data cells, and a second plu-

rality of high resolution information encoded data cells at least partially superimposed with said first plurality of low resolution information encoded data cells and encoding information independent of said first plurality of low resolution information encoded data cells, wherein each of said second plurality of high resolution information encoded data cells is smaller than each of said first plurality of low resolution information encoded data cells, a method for reading said optically encoded multiple resolution label, said method comprising:

capturing a two dimensional image for storage in a memory, said stored two dimensional image containing an image of said optical encoded multiple resolution label anywhere within the field of view of said stored two dimensional image;

detecting the location of said optically encoded multiple resolution label within said stored two dimensional image;

decoding said low resolution information encoded data cells; and

decoding said second plurality of high resolution information encoded data cells.

8. A method in accordance with claim 7, wherein said high resolution information encoded data cells of said optically encoded multiple resolution label are disposed in predetermined relation to said low resolution information encoded data cells, and wherein said step of decoding said high resolution information encoded data cells further comprises:

locating said low resolution information encoded data cells; and

locating said high resolution information encoded data cells at said predetermined relation to said located low resolution information encoded data cells.

9. A method in accordance with claim 8, wherein said multiple resolution optically encoded label includes a finder pattern having a plurality of spots arranged in a predetermined geometric pattern, said low resolution information encoded data cells being arranged in a two dimensional array having a predetermined geometric pattern similar to said predetermined geometric pattern of said plurality of spots of said finder pattern, said step of locating said low resolution information encoded data cells further comprises:

detecting said spots of said finder pattern; and

detecting said low resolution information encoded data cells using the detected geometric pattern of said detected finder spots.

10. In a reader in accordance with claim 7, wherein each of said high resolution information encoded data cells is disposed within one of said low resolution information encoded data cells, and wherein the position of said high resolution information encoded data cell within said low resolution information encoded data cell represents the data encoded by said high resolution information encoded data cell, said method of decoding said high resolution information encoded data cell further comprises:

providing a first signal indication for a first position of said high resolution information encoded data cell within said low resolution information encoded data cell; and

providing a second signal indication for a second position of said high resolution information encoded data cell within said low resolution information encoded data cell.

11. A reader in accordance with claim 7, further including a plurality of said high resolution information encoded data cells, wherein at least one of said plurality of second plurality of high resolution information encoded data cells is disposed within said low resolution information encoded data cell, and wherein the number of said high resolution information encoded data cells within said low resolution information encoded data cell represents the data encoded by each of said plurality of second plurality of high resolution information encoded data cells, said method of decoding said high resolution information encoded data cells further comprises:

providing a first signal indication for a first number of said high resolution information encoded data cells within said low resolution information encoded data cell; and

providing a second signal indication for a second of number of said high resolution information encoded data cells within said low resolution information encoded data cell.

12. A reader in accordance with claim 7, wherein the shape of said high resolution information encoded data cell represents the data encoded by said high resolution information encoded data cell, said method of decoding said high resolution information encoded data cells further comprises:

providing a first signal indication for a first shape of said high resolution information encoded data cell within said low resolution information encoded data cell; and

providing a second signal indication for a second shape of said high resolution information encoded data cell within said low resolution information encoded data cell.

13. A reader in accordance with claim 7, wherein the orientation of said high resolution information encoded data cell represents the data encoded by said high resolution information encoded data cell, said method of decoding said high resolution information encoded data cells further comprises:

providing a first signal indication for a first orientation of said high resolution information encoded data cell within said low resolution information encoded data cell; and

providing a second signal indication for a second orientation of said high resolution information encoded data cell within said low resolution information encoded data cell.

14. A reader in accordance with claim 7, wherein the reflective optical property of said high resolution information encoded data cell represents the data encoded by said high resolution information encoded data cell, said method of decoding said high resolution information encoded data cells further comprises:

providing a first signal indication for a first reflective property of said high resolution information encoded data cell within said low resolution information encoded data cell; and

providing a second signal indication for a second reflective property of said high resolution information encoded data cell within said low resolution information encoded data cell.

15. A reader in accordance with claim 7, wherein the size of said high resolution information encoded data cell represents the data encoded by said high resolution information encoded data cell, said method of decoding